

MODIS Calibration Panel Meeting

Report on the

MODIS Characterization Support Team (MCST)

by

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NASA Goddard Space Flight Center

Greenbelt, MD

MODIS Science Team Meeting, Oct. 1 - 3, 1991. Attachment V

MCST Presentation Topics

MCST Overview

- **Organization Charts**
- **Objectives/Approach**

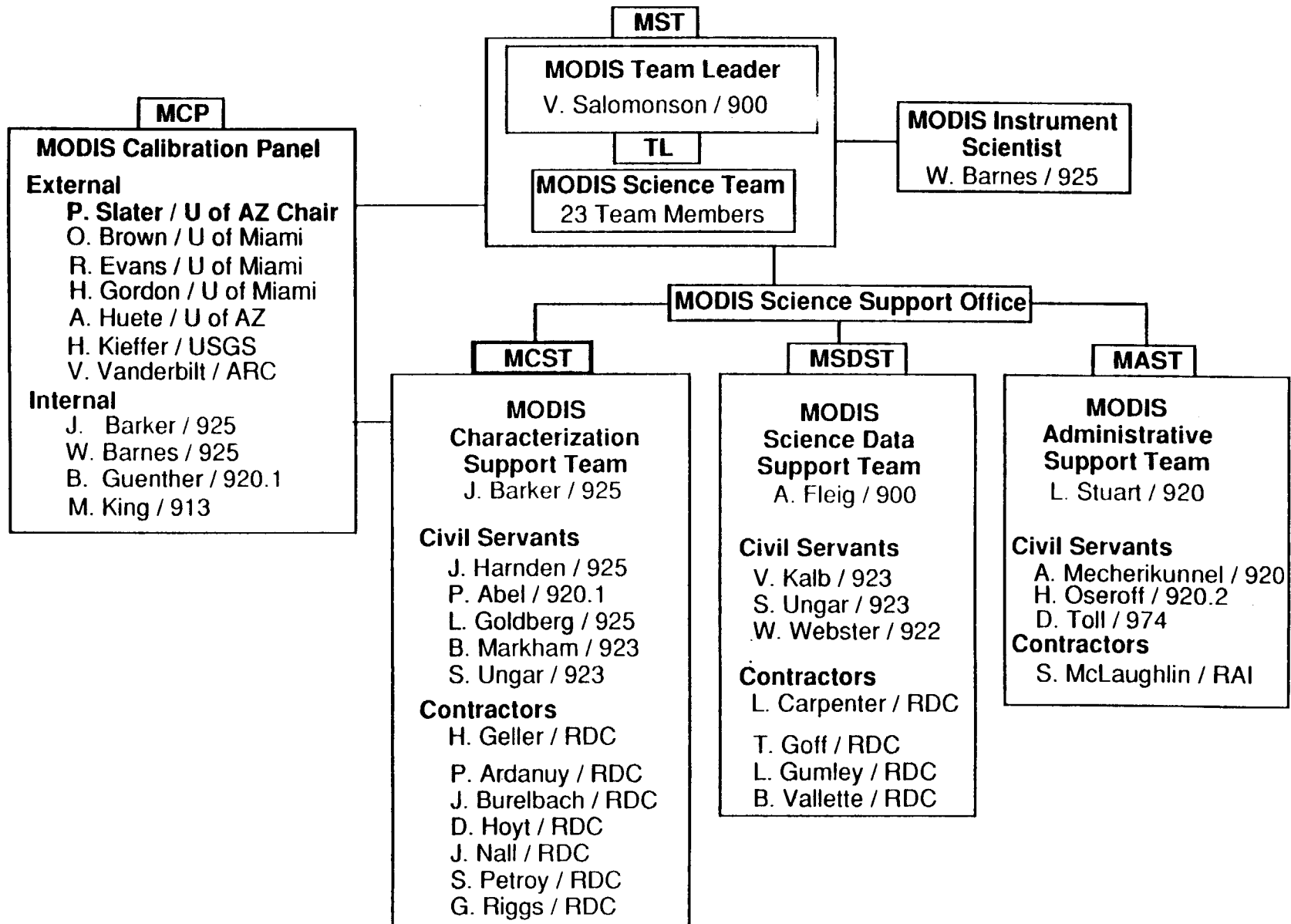
MCST Activities

- **MCST Produced Responses and Documents**
- **Instrument Builders' Documents**
- **Geometry Requirements and Goals Table**
- **Registration Sensitivity**
- **Calibration Handbook**

MCST Status

- **Geometric Knowledge and Control Response and Document**
- **Calibration Site Selection**
- **End-to-End Model**
- **Flight Operations Characteristics**
- **Cross-Comparison of Instruments**

MODIS Science Team Organization Chart



MCST Overview

MCST Objectives

Support MODIS

- Team Leader
- Team Members
- Interface Between Engineers & Scientists
- EOS Instrument Managers
- EOS Flight Operations Managers

For MODIS Instrument

- Characterization / Calibration
- Parametric Sensitivity
- Simulated Imagery
- Utility Products

During All Phases

- Pre-Launch Fabrication and Integration
- On-Orbit Operational
- End-of-Life

MCST Priorities

1. **Instrument-Related System Characterization/Calibration**
2. **Algorithms and Hardware for ICC/MCST Monitoring of In-Orbit Data**
3. Utility Products
4. Simulated MODIS Imagery
5. Cooperative TM-MCST Discipline-Related Product Sensitivity to Calibration

Primary MCST Responsibilities

Instrument-Related System Characterization/ Calibration

At-Launch

Products*

- "Level-1A" "Math" Model
- "Level-1A" Systematic Radiometric Correction Parameters / Characteristics
- "Level-1A" Systematic Geometric Correction Parameters / Characteristics
- "Level-1A" Systematic Spectral Correction Parameters / Characteristics
- "Level-1B" At-Satellite Radiances
- "Level-2" Exoatmospheric Reflectances

Post-Launch

Updated Products*

- "Level-1A" Systematic Radiometric Correction Parameters / Characteristics
- "Level-1A" Systematic Geometric Correction Parameters / Characteristics
- "Level-1A" Systematic Spectral Correction Parameters / Characteristics
- "Level-1B" At-Satellite Radiances
- "Level-2" Exoatmospheric Reflectances

New Products*

- "Level-1B" Solar Calibration Datasets
- "Level-1B" Lunar Calibration Datasets
- "Level-2" Solar Irradiances
- "Level-2" Lunar Irradiances

* MCST-generated algorithms and software for operational products, including algorithms for automated quality assurance, metadata, and browse products, are to be rehosted to EOSDIS by MSDST

"Calibration Plan"

Objective

"Official Algorithms"

Develop and maintain "official" "Level-1A to 1B" algorithms

- for both MODIS-N and MODIS-T instruments
- with a unique version number updated with time
- integrated from various sources of information
- for radiometric, geometric, and spectral characteristics and models

"Calibration Plan"

Assumptions

Alternative Algorithms

Several alternative calibration algorithms
need to be in place throughout 15-year mission
in order to provide alternatives and verification
for the unique "official" calibration algorithms

Precision

Quantitative characterization and monitoring
of the precision of alternative algorithms
will occur on a time scale of months

Accuracy

Quantitative characterization and monitoring
of the accuracy of alternative algorithms
will occur on a time scale of years

Models

Development of a self-consistent collection of calibration models
will occur on a time scale of a decade

MCST Produced Responses and Documents

Responses:

- MODIS AUG91 Response to GE Platform Questionnaire (DEC90)
- MODIS JUN91 Response to EOS Cross-Calibration Questionnaire (APR91)

Documents:

- Science Calibration Plans
 - MODIS-N Science Calibration Plan, Ver. 0.9
 - MODIS-T Science Calibration Plan, Ver. 0.9
- EOS Reference Handbook Input (user guide for scientists)
 - MODIS-N Calibration Handbook, Ver. 0.9
 - MODIS-T Calibration Handbook, Ver. 0.9
- Scientific Requirements defining Instrument Specifications
 - MODIS-N Science Requirements, Ver. 0.9
 - MODIS-T Science Requirements, Ver. 0.9

Documents Expected From MODIS-N (SBRC)

Preliminary Plans (delivered 17 SEP 91)

- MODIS-N Calibration Management Plan
- MODIS-N Performance Verification Plan

Final Plans (to be delivered one day before PDR for EOS review)

- MODIS-N Calibration Management Plan
- MODIS-N Performance Verification Plan

Operational Documents

- User's Guide for Operating MODIS-N
(delivered via MCST to ICC/EOC/ECS/EOSDIS
on same schedule as algorithms)
- Results of Pre-Launch Characterization and Calibration
(delivered by Instrument following Pre-Ship Reviews)

Documents Expected From MODIS-T (Code 700)

Preliminary Outlines (delivered 17 SEP 91)

- MODIS-T Calibration Management Plan
- MODIS-T Performance Verification Plan

Final Plans (to be delivered one day before PDR for EOS review)

- MODIS-T Calibration Management Plan
- MODIS-T Performance Verification Plan

Operational Documents

- User's Guide for Operating MODIS-T
(delivered via MCST to ICC/EOC/ECS/EOSDIS
on same schedule as algorithms)
- Results of Pre-Launch Characterization and Calibration
(delivered by Instrument following Pre-Ship Reviews)

MODIS Geometry Requirements Table from response to GE questionnaire

Parameter	Reference Axis	MODIS Instrument Requirement		EOS Observatory Requirement		End-to-End Requirement		RT or PP (Note 1)
Pointing Knowledge		arc seconds	meters at Nadir	arc seconds	meters at Nadir	arc seconds	meters at Nadir	
	x	90	(310)	108	(370)	(141)	(480)	PP (Note 3)
	y	90	(310)	108	(370)	(141)	(480)	PP (Note 3)
	z	90	(310)	108	(370)	(141)	(480)	PP (Note 3)
Pointing Accuracy		arc seconds	meters at Nadir	arc seconds	meters at Nadir	arc seconds	meters at Nadir	
	x	(2550)	(8700)	(2550)	(8700)	3600	(12000)	RT
	y	(2550)	(8700)	(2550)	(8700)	3600	(12000)	RT
	z	(2550)	(8700)	(2550)	(8700)	3600	(12000)	RT
Stability		Arc Seconds per second	Meters per second	Arc Seconds per second	Meters per second	Arc Seconds per second	Meters per second	
	x	(510)	(1740)	(510)	(1750)	720	(2460)	RT
	y	(20)	(70)	(20)	(70)	28	(96)	RT
	z	(20)	(70)	(20)	(70)	720	(2460)	RT

Note 1: Specify RT for real-time or PP for post-processed performance.

Note 2: List maximum peak-to-peak excursion in arcseconds and corresponding time period. All periods of interest should be listed. For example, 8 arcseconds in 10 seconds and 15 arcseconds in 500 seconds is the form of the response required.

Note 3: To be available at the same time as Level-0 instrument data.

() Parentheses indicate derived numbers.

MODIS Geometry Goal Table from response to GE questionnaire

Parameter	Reference Axis	MODIS Instrument Goal		EOS Observatory Goal		End-to-End		RT or PP (Note 1)
Pointing Knowledge		arc seconds	meters at Nadir	arc seconds	meters at Nadir	arc seconds	meters at Nadir	
	x	(50)	(175)	(50)	(175)	(73)	250	PP (Note 3)
	y	(50)	(175)	(50)	(175)	(73)	250	PP (Note 3)
	z	(50)	(175)	(50)	(175)	(73)	250	PP (Note 3)
Pointing Accuracy		arc seconds	meters at Nadir	arc seconds	meters at Nadir	arc seconds	meters at Nadir	
	x	(2550)	(8700)	(2550)	(8700)	3600	(12000)	RT
	y	(2550)	(8700)	(2550)	(8700)	3600	(12000)	RT
	z	(2550)	(8700)	(2550)	(8700)	3600	(12000)	RT
Stability		Arc Seconds per second	Meters per	Arc Seconds per second	Meters per second	Arc Seconds per second	Meters per second	
	x	TBD	TBD	TBD	TBD	TBD	TBD	RT
	y	TBD	TBD	TBD	TBD	TBD	TBD	RT
	z	TBD	TBD	TBD	TBD	TBD	TBD	RT

Note 1: Specify RT for real-time or PP for post-processed performance.

Note 2: List maximum peak-to-peak excursion in arcseconds and corresponding time period. All periods of interest should be listed. For example, 8 arcseconds in 10 seconds and 15 arcseconds in 500 seconds is the form of the response required.

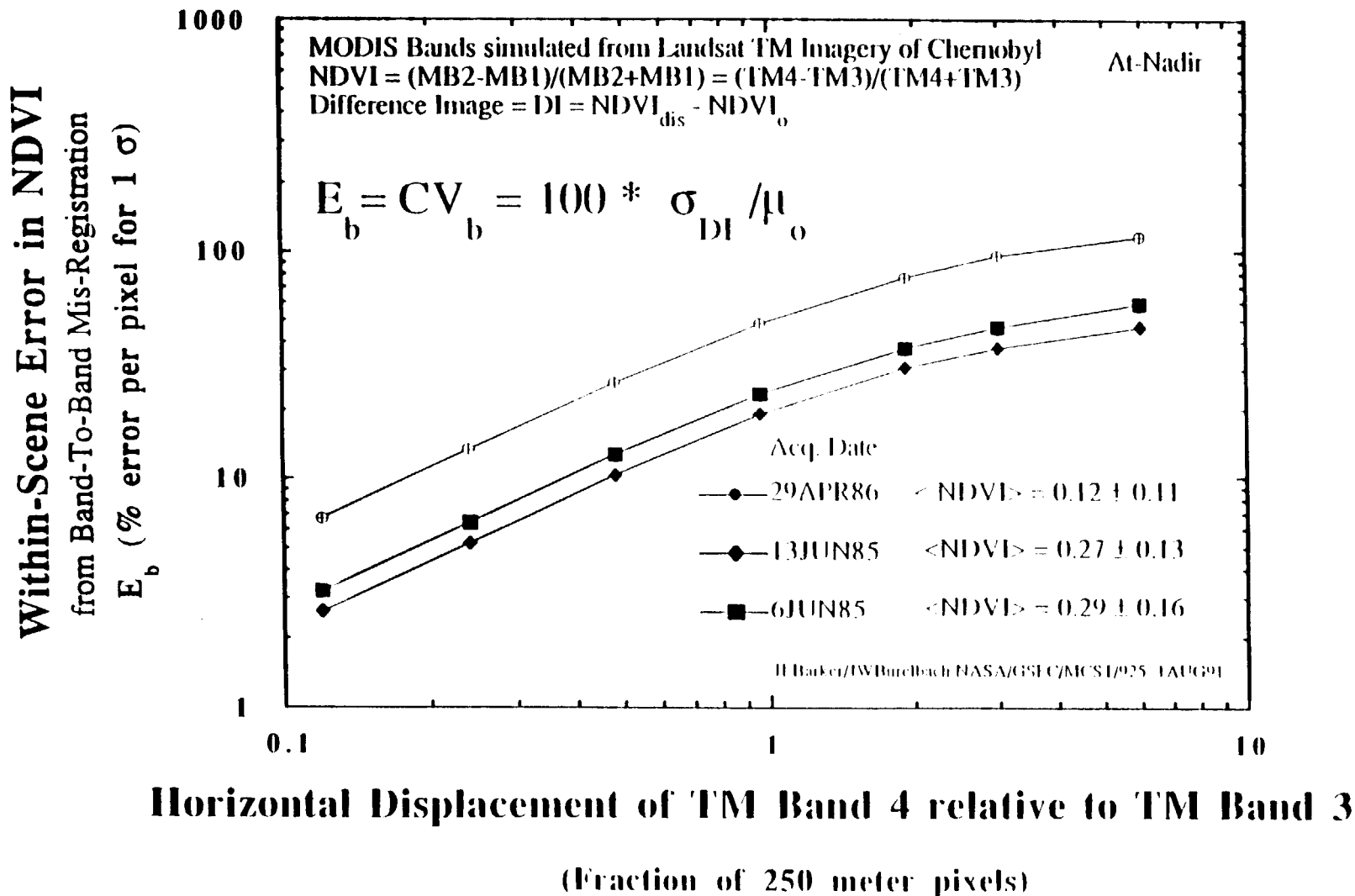
Note 3: To be available at the same time as Level-0 instrument data.

() Parentheses indicate derived numbers.

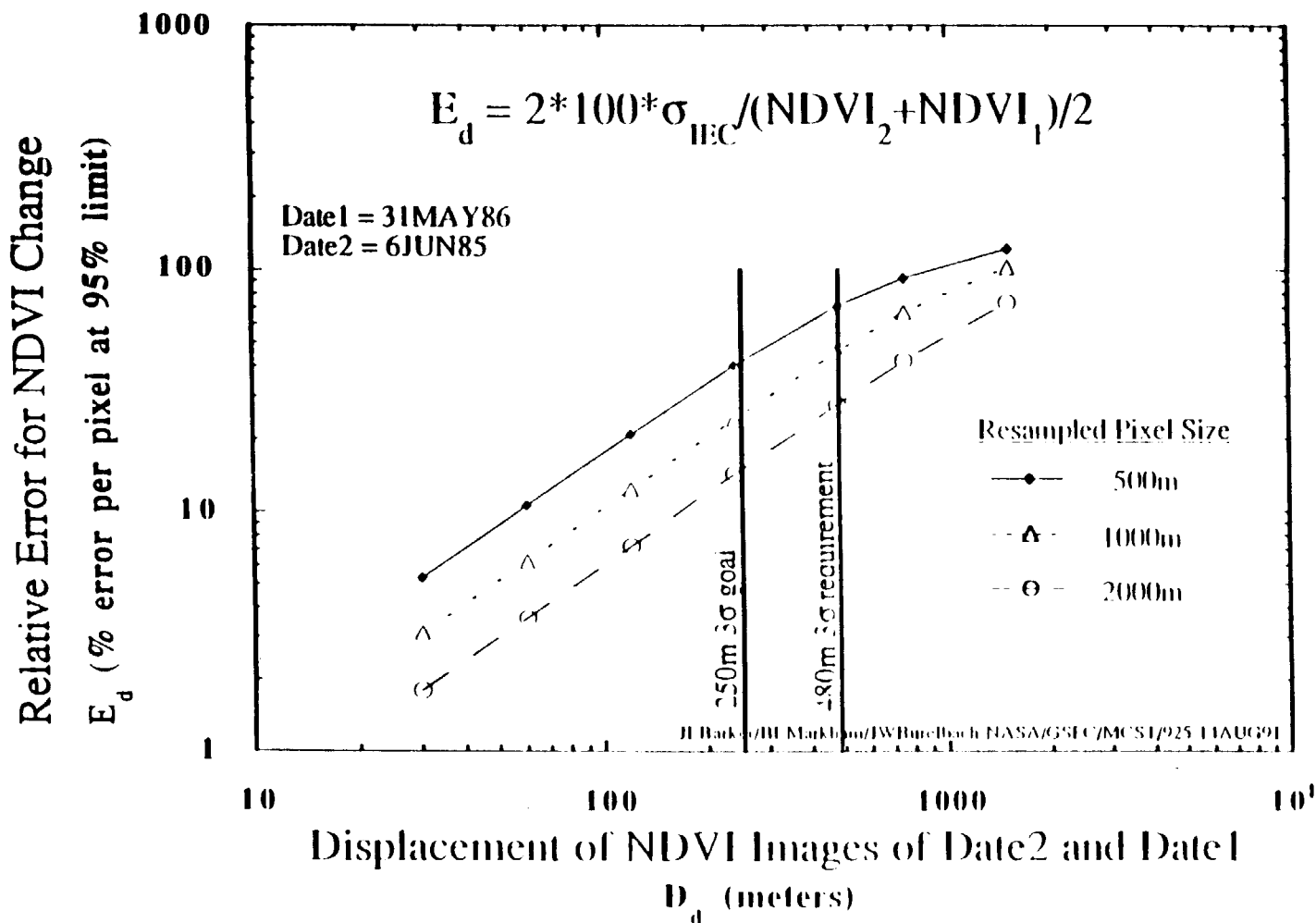
MODIS-N Band-to-Band Registration Sensitivity

for measuring an NDVI vegetation index over land within a single scene

(MODIS-N Band-to-Band Registration Requirement is 0.1 Pixel)



MODIS Scene-to-Scene Registration Sensitivity



Outline and Responsibilities for MODIS-N Calibration/ Characterization Plan

Introduction	Barker, Petroy
Pre-Launch Calibration/Characterization Methodology	SBRC-Hughes
In-Orbit Radiometric Calibration/Characterization Methodology	
Instrument-Based Calibration	
Internal sources	Barker, Petroy
External solar	Guenther, Barker, Geller, Hoyt, Mecherikunnel
External lunar	Kieffer, Hoyt
Instrument Cross-Comparison	
Cross-Sensor/within platform	Ungar, R.Muller
Cross-Platform In-Orbit	Ungar
Target Related/Aircraft	Abel, Guenther, King, Brown, Ungar
Target-Based Calibration	
Target Related/Ground Reflectance	Slater et al., Markham
Bio-Optical Oceans	Evans, Esaias
Image-Related	
Radiometric Rectification	Hall, Barker
Class-Specific Scene Equalization	Barker, Markham, Burelbach
In-Orbit Geometric Calibration	Barker, Goldberg, Petroy
In-Orbit Spectral Calibration	Barker, Goldberg, Petroy
Official MODIS-N/MCST Calibration Algorithm	Barker, Petroy
Algorithm Sensitivity/Simulation Studies	Barker, Markham, Ungar, Justice, Townsend, Esaias, King

Outline and Responsibilities for MODIS-T Calibration/ Characterization Plan

Introduction	Barker, Petroy
Pre-Launch Calibration/Characterization Methodology	GSFC Code 700
In-Orbit Radiometric Calibration/Characterization Methodology	
Instrument-Based Calibration	
Internal sources	Barker, Petroy
External solar	Guenther, Barker, Geller, Hoyt, Mecherikunnel
External lunar	Kieffer, Hoyt
Instrument Cross-Comparison	
Cross-Sensor/within platform	Ungar, R.Muller
Cross-Platform In-Orbit	Ungar
Target Related/Aircraft	Abel, Guenther, King, Brown, Ungar
Target-Based Calibration	
Target Related/Ground Reflectance	Slater, Markham
Bio-Optical Oceans	Evans, Esaias
Image-Related	
Radiometric Rectification	Hall, Barker
Class-Specific Scene Equalization	Barker, Markham, Burelback
In-Orbit Geometric Calibration	None Currently Planned
In-Orbit Spectral Calibration	Barker, Ungar, Petroy
Offical MODIS-T/MCST Calibration Algorithm	Barker, Petroy
Algorithm Sensitivity/Simulation Studies	Barker, Markham, Ungar, Justice, Townsend, Esaias, King

Outline of MODIS-N/ T Calibration Handbooks

- 1 Introduction
 - 1.1 Overview
 - 1.2 Science Calibration/Characterization Objectives
 - 1.3 Organizations and Responsibilities
 - 1.4 Schedules
- 2 Pre-Launch Calibration/Characterization Methodology
 - 2.1 Objectives/Rationale
 - 2.2 Radiometric Calibration
 - 2.3 Geometric Calibration
 - 2.4 Spectral Calibration
- 3 In-Orbit Radiometric Calibration/Characterization Methodology
 - 3.1 Objectives/Rationale
 - 3.2 Instrument-Based Calibration
 - 3.3 Instrument Cross-Comparison
 - 3.4 Target-Based Calibration
 - 3.5 Image-Related
- 4 In-Orbit Geometric Calibration
- 5 In-Orbit Spectral Calibration
- 6 Official MODIS /MCST Calibration Algorithm
 - 6.1 Objectives/Rationale
 - 6.2 Algorithm Sensitivity/Simulation Studies
- 7 Definitions and References
 - 7.1 Data Dictionary/Glossary
 - 7.2 Acronyms
 - 7.3 References

MCST Activities and Status

Geometric Knowledge and Control

A draft response to the platform integrator has been released.

Questions remain as to the appropriateness of goals vs. requirements.

Calibration Site Selection

Scenes are being analyzed for homogeneous areas for use in the testing of data.

MODIS Radiometric Models

Code 925 Spreadsheet Model (RAI)

Code 725 MODIS-T Radiometric Model

Code 71~~3~~₇ MODIS-T Calibration Model

MCST Activities and Status

MODIS End-To-End Models

A spreadsheet at-satellite radiance model has been developed from the 5-S code with incorporation from Lowtran-7.

Code 700 has provided a spreadsheet model of at sensor radiances.

Work proceeds in linking the two models to obtain an end-to-end model.

The end-to-end spreadsheet model will be converted to C.

MODIS Operational Characteristics

MODIS-N in-orbit scenerios being developed.

Cross-Calibration

Pre-launch and in-orbit comparisons are being identified.

MCST Action Items From February MST Meeting and Status Thereof

- 1. Perform a first cut selection of the uniform "super" test sites on the North American continent using available AVHRR data sets.**
MCST is examining the AVHRR North America data and has produced an NDVI image as well as a 3x3 travelling average with additional pixel statistics.
- 2. Look at MODIS snow and cloud masks.**
MCST has been examining the snow/cloud discrimination issue using Landsat TM data and determining the optimal threshold algorithm applicable.
- 3. Discuss incorporation of higher level data products in the calibration algorithms at greater length at the next Science Team meeting.**
Required action not clear. Requires further definition.
- 4. Require adequate time in the vendor and GE integration for cross-calibration testing.**
MCST has noted this issue and is in contact with the GE integration team.
- 5. In cooperation with P. Menzel, verify methodology used by MODIS Science Data Support Team.**
MCST is in constant contact with the MODIS Science Data Support Team (MSDST) and Paul Menzel, and will verify the methodology once the MSDST has completed its work on the development.

Material Available From MCST

Document / Presentation

MODIS-N Calibration Handbook

MODIS-T Calibration Handbook

MODIS-N Science Calibration/Characterization Plan

MODIS-T Science Calibration/Characterization Plan

MODIS Geometry Requirements

MODIS Geometry Response to GE Questionnaire

MODIS-N Preliminary Performance Verification Plan

MODIS-N Preliminary Calibration Management Plan

MODIS-T Outline of Calibration Management Plan

MODIS-T Radiometric Model Spreadsheet w/comments

MCST Presentation for 30 September - AM

MCST Presentation for 30 September - PM#1 (MODIS-T Cal/Val)

MCST Presentation for 30 September - PM#2 (Science Cal Plans)

MCST Presentation for 2 October - Atmosphere

MCST Presentation for 2 October - Land

MCST Presentation for 2 October - Ocean

MCST Feedback Sheet

Questions ?

Concerns ?

Suggestions ?

Actions for Next Meeting?

Name:

Date:

For E-mail correspondence address GSFCmail:JBarker, JIlarnden, or HGeller.

For updates on the latest events and available documents, CHECK MCST.BB bulletin board on GSFCmail.